

The National & Cooperative CORS Program

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National Geodetic Survey
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CORS Users Forum
Silver Spring, MD
April 19, 2002



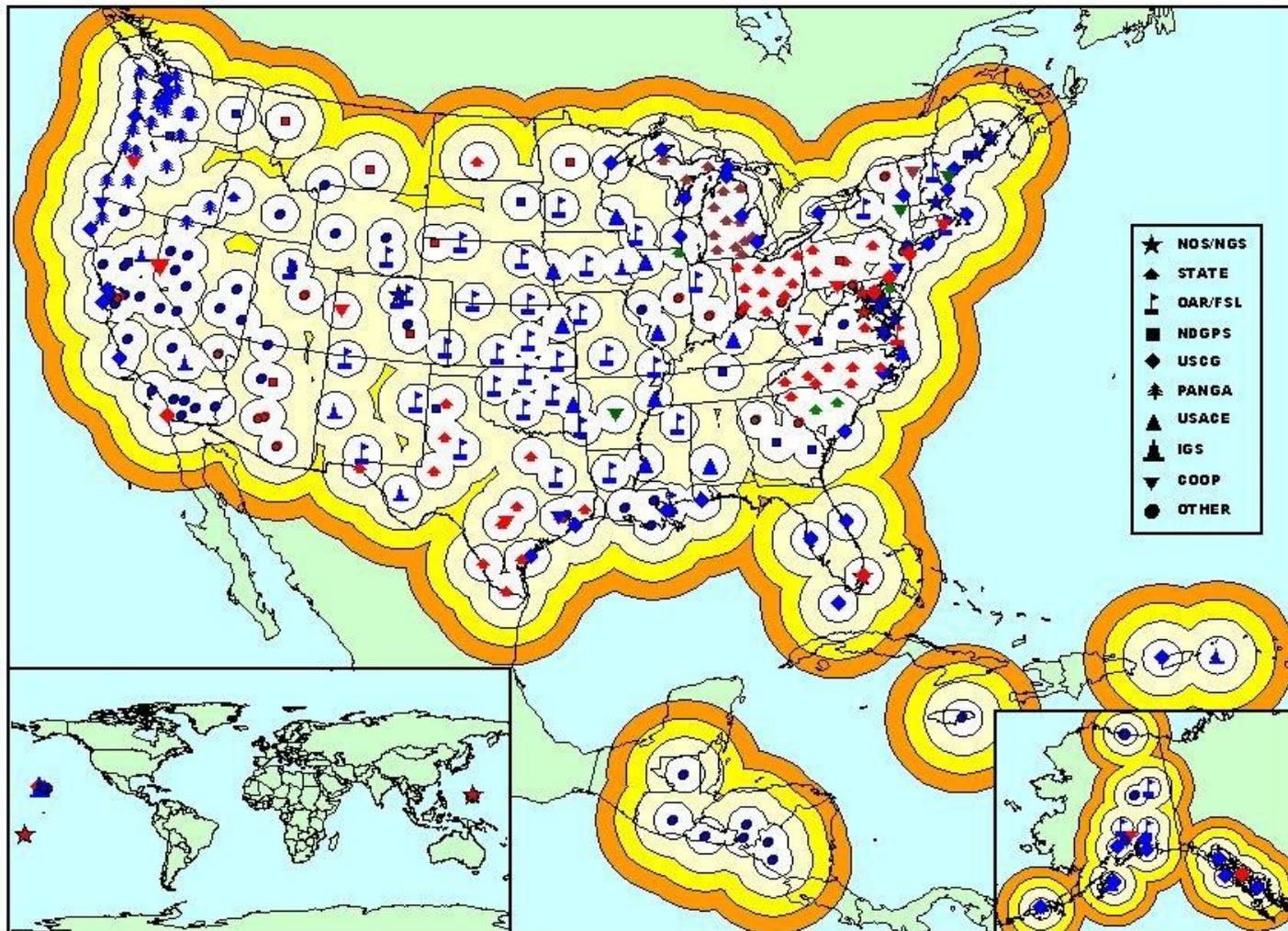
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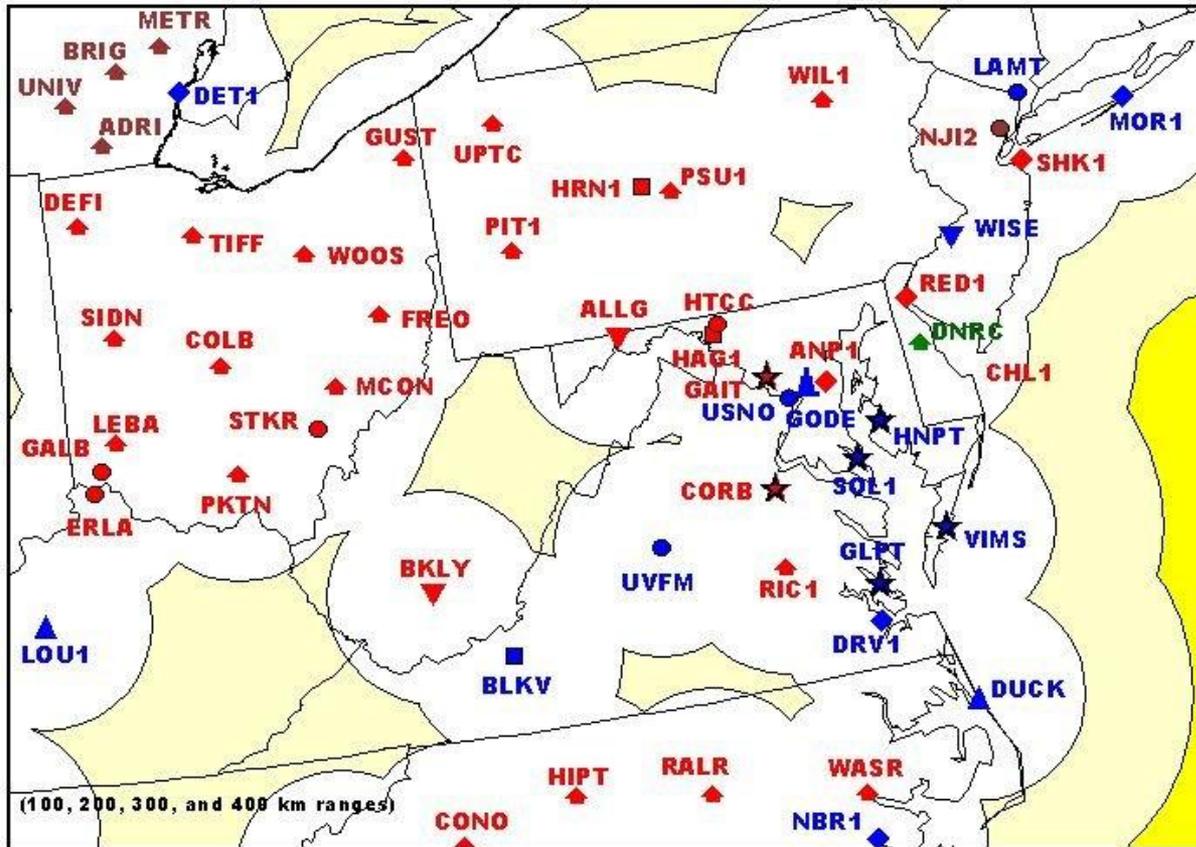
Continuously Operating Reference Stations

CORS Coverage (100, 200, 300, and 400 km radius) March 2002



Symbol color denotes sampling rates: (1 second) (5 seconds) (15 seconds) (30 seconds)

Regional CORS Coverage



1/2002

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CORS SITES



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CORS OVERVIEW

- Network contained 279 sites as of April 2002
- Growing at rate of 6 sites per month
- Provides code range (C/A, P1, P2)
 - and carrier phase observations (L1, L2)
- Provides meteorological data at some sites
- Designed to meet post-processing requirements for
 - Positioning
 - Navigation
 - Meteorology
 - Geophysics



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CORS OVERVIEW-CONTINUED

- National CORS data transferred to NGS's office in MD
- GPS and “met” data converted to RINEX format
- Data made available to public via:
 - World Wide Web
 - File transfer protocol
- Data kept online for at least 4 years
- Data archived on CD-ROMs



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COOPERATIVE CORS

- GPS base stations whose data are freely disseminated by cooperating organizations
- NGS provides link from its web site to that of each cooperating organization
- Site coordinates must be consistent with the National Spatial Reference System



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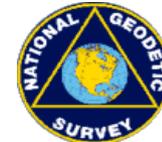
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National CORS & Cooperative CORS

National CORS	Cooperative CORS
- Station commits to a long-term and continuous operation	- Station operates at least 8hrs/day; 5days/week
- Data are available online via the NGS CORS web page	- Provides a link to the participant's web page
- All data are permanently archived in NGS	- Minimum 7 days' data online at the participant's web site
- antenna position re-computed everyday	- antenna position re-computed every 90 days or less

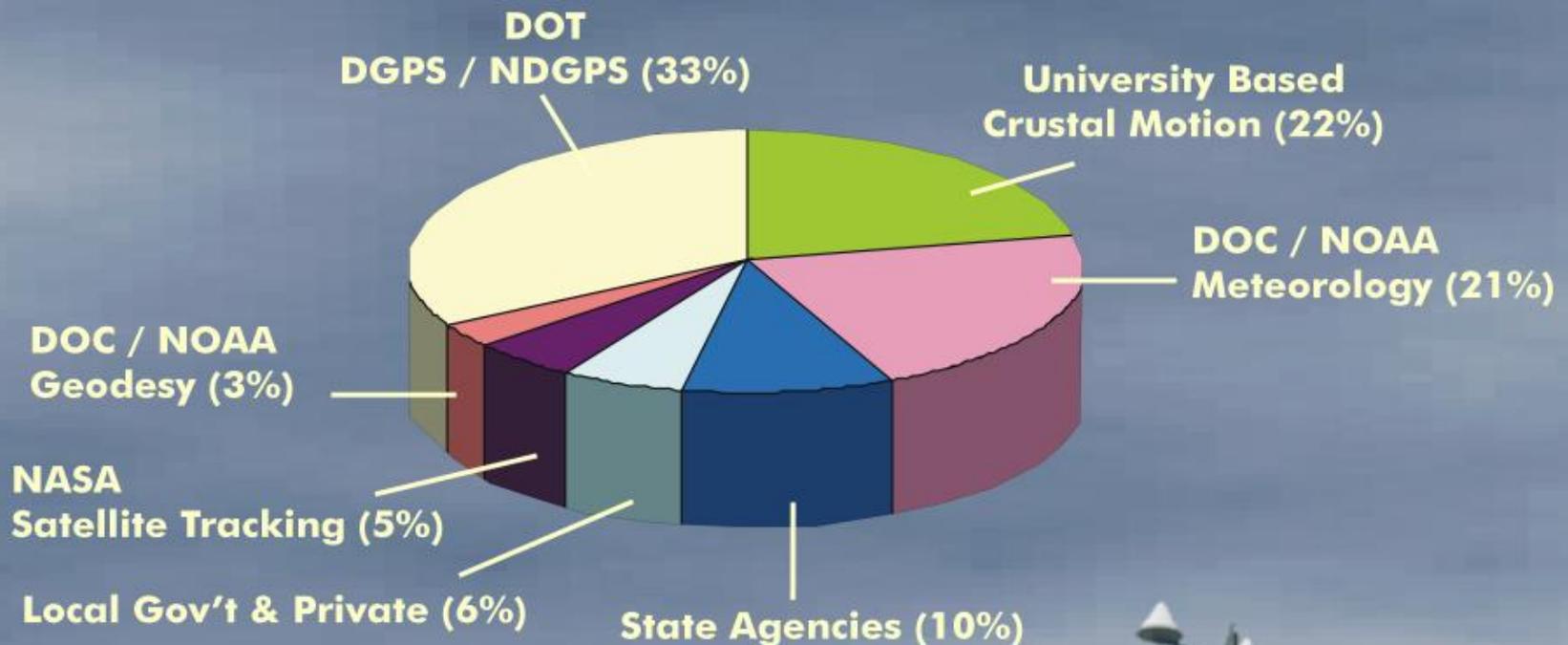


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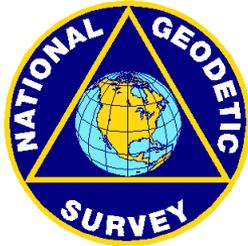


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National CORS Partners



CORS PARTNERS: FEDERAL



Federal Highway Administration

Federal Railway Administration

Federal Aviation Administration

Forecast Systems Laboratory

NASA

US Geological Survey

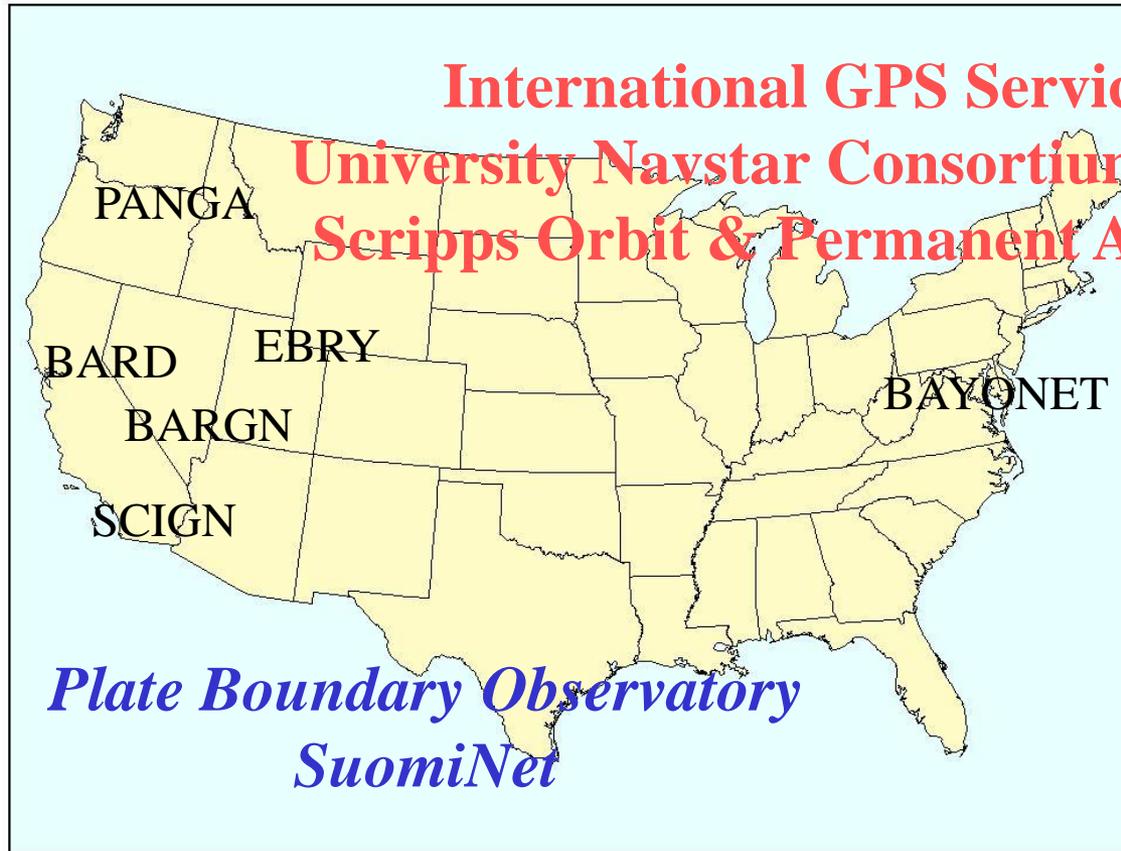
US Army Corps of Engineers

US Air Force

US Naval Observatory



CORS PARTNERS: SCIENTIFIC



International GPS Service (IGS)
University Navstar Consortium (UNAVCO)
Scripps Orbit & Permanent Array Center



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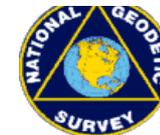


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CORS PARTNERS: INTERNATIONAL



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CORS Partners: Private Industry

“ If you want to see where GPS is going, then keep your eye on the GPS manufacturers.”

Bill Strange
Former Manager
National CORS Program

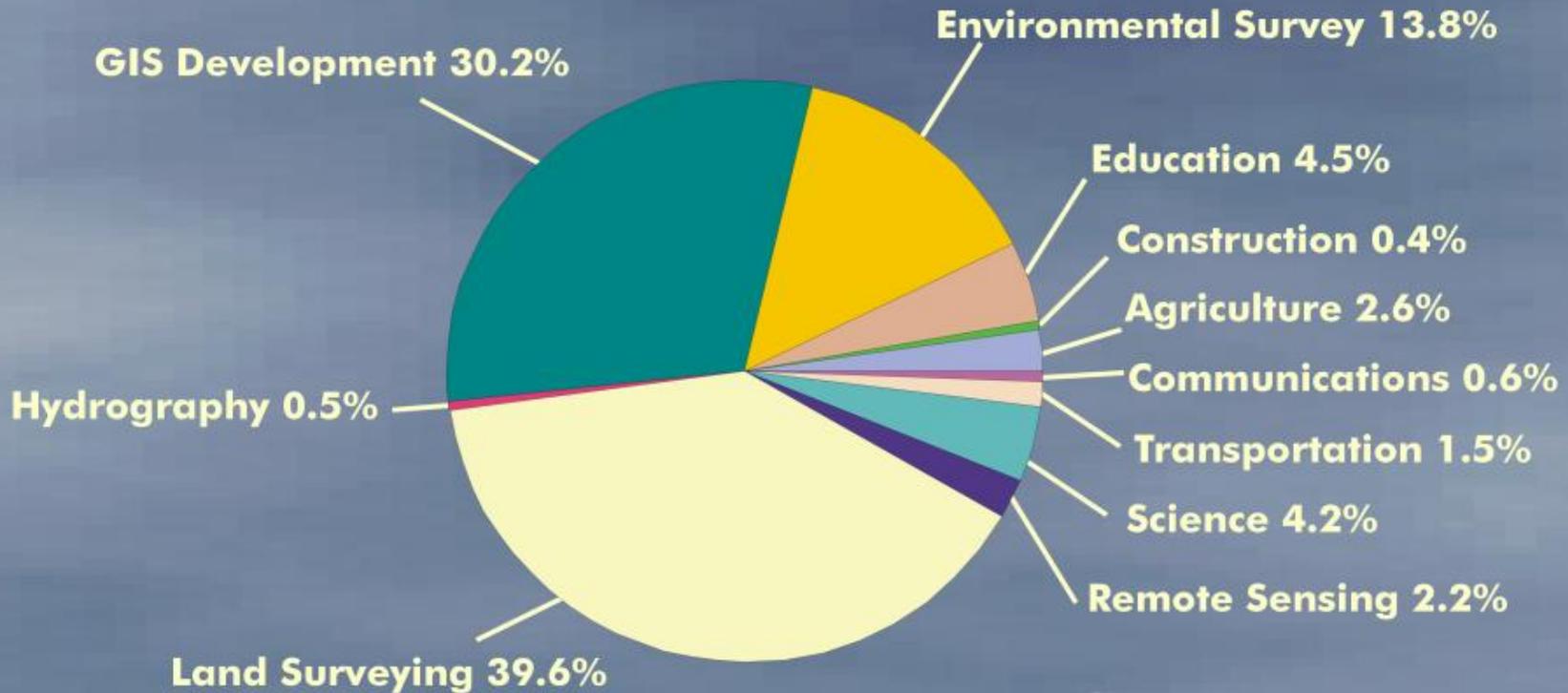


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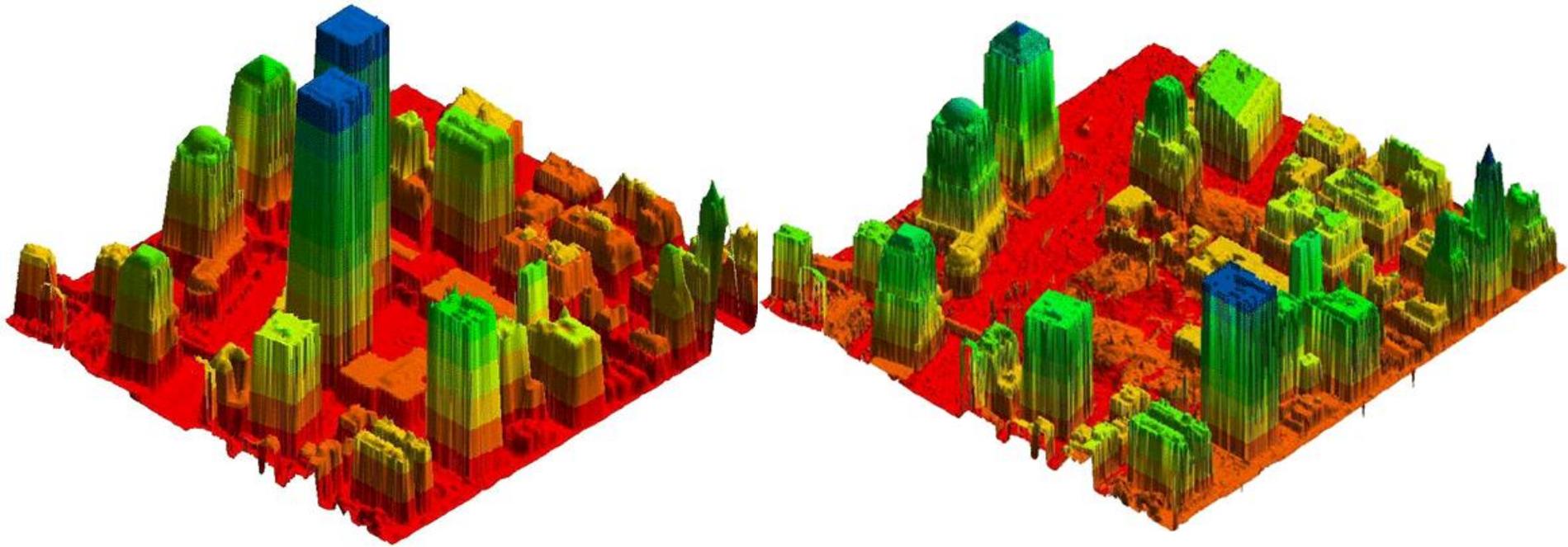
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CORS Applications



5,646
Survey responses
Fall 1999

LIDAR images of Manhattan before and after 11 SEP 2001



These images are computerized visualizations of elevation information of the World Trade Center from before (July 2000) and after (September 15, 2001) the attack. These maps were produced using an airborne LIDAR (Light Detection and Ranging) system. The LIDAR system creates detailed and highly accurate elevation information by the precise timing of thousands of laser pulses striking the ground surface. These data can be manipulated in the digital environment to create an array of maps and views of the project site and to obtain precise measurements of structures, debris fields, and other vital information. These images were generated by EarthData (www.earthdata.com), and the aircraft was positioned using CORS data from the NJI2 site which is operated by the New Jersey Institute of Technology.

CORS for Airborne Mapping

Applanix Corporation performed two experiments to determine how accurately the position of an aircraft can be computed using interpolated GPS data from sites in the CORS network, even though these sites may be up to 420 km from the flight path.

Location	San Jose, CA	Dallas, TX
Date of Flight	June 2000	Jan. 2001
Flight Duration	4 hours	4 hours
Aircraft Altitude	~1100 m	~1500 m

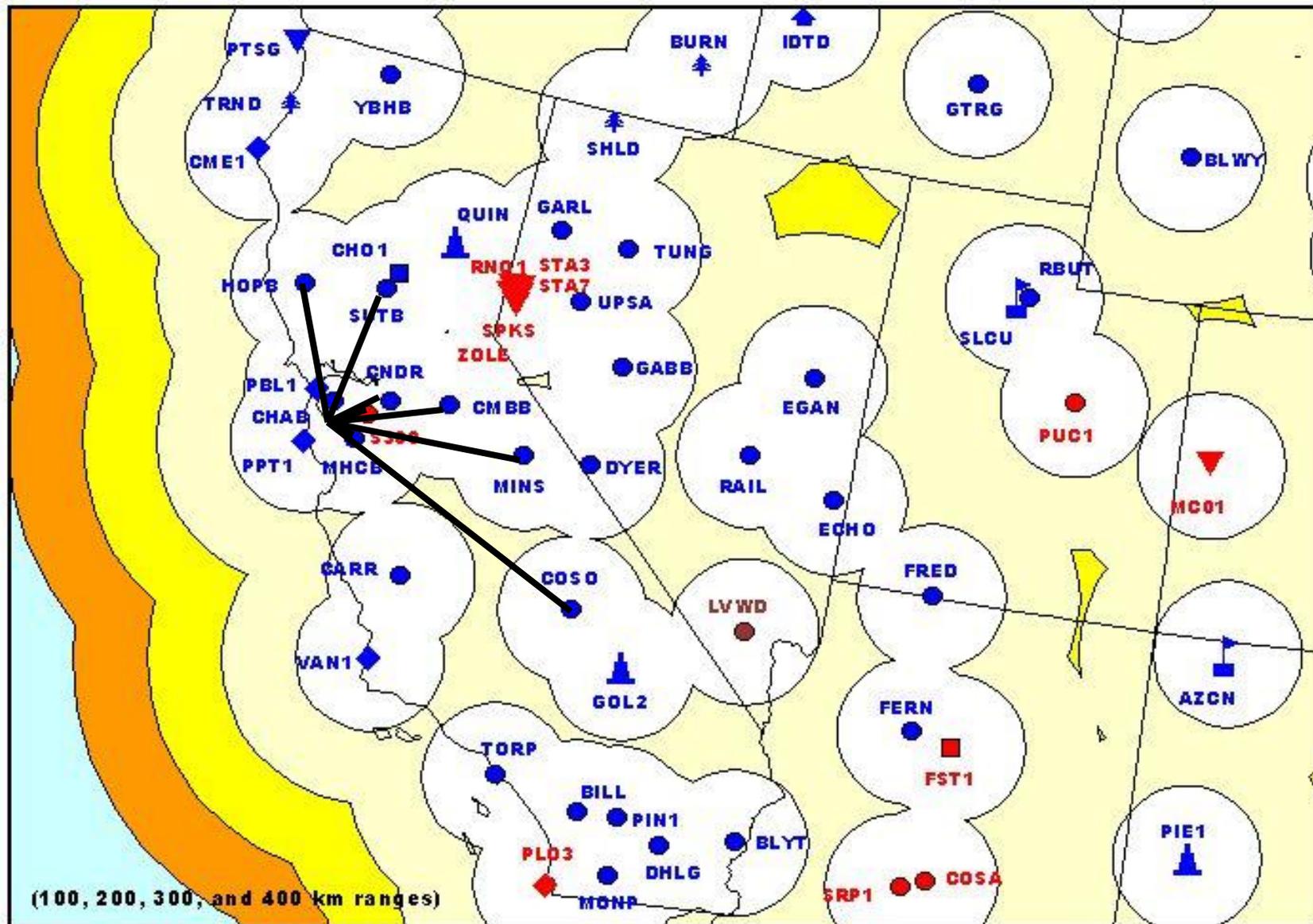


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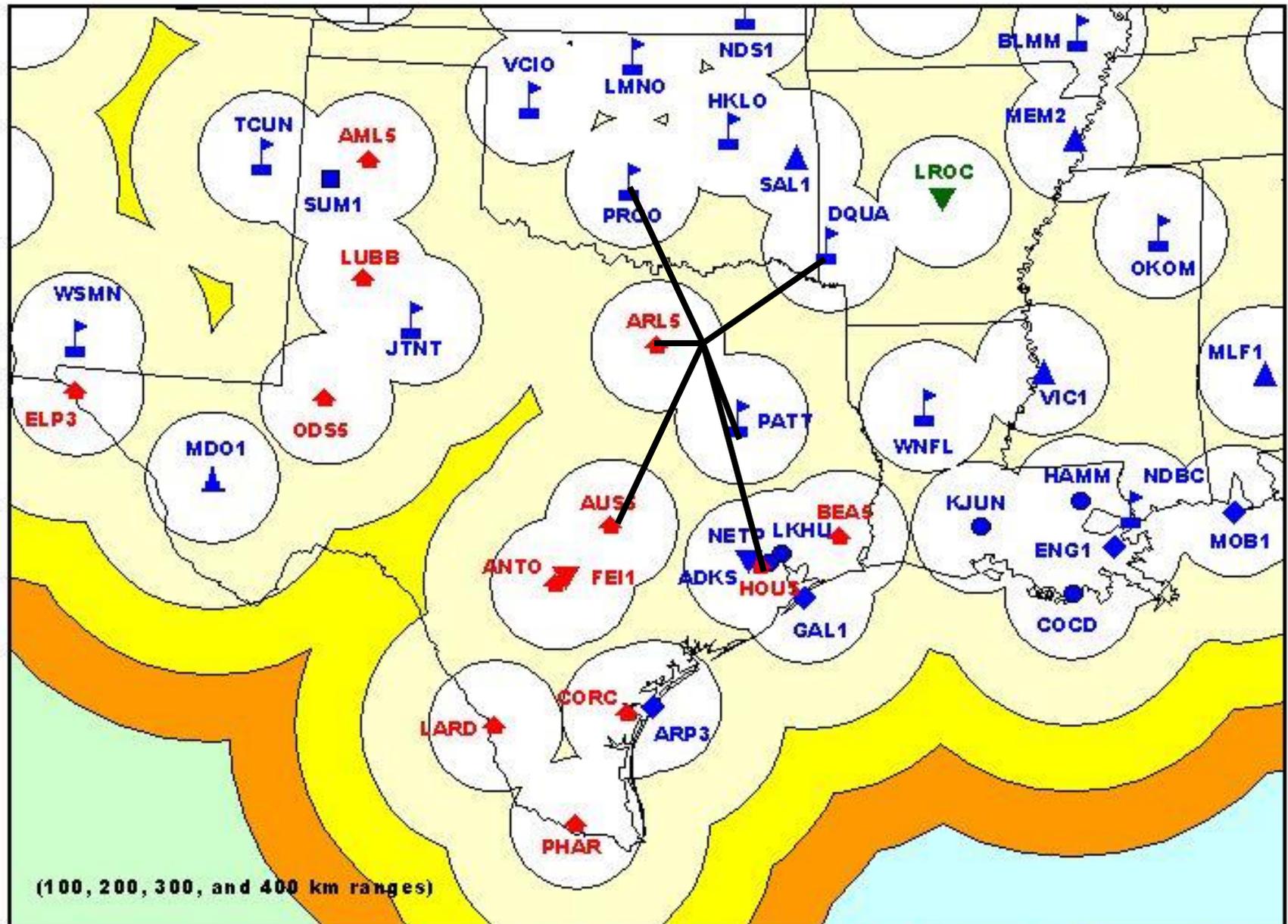
CORS Used to Position Aircraft



1/2002

Symbol color denotes sampling rates: (1 second) (5 seconds) (15 seconds) (30 seconds)

CORS Used to Position Aircraft



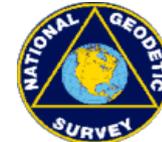
Symbol color denotes sampling rates: (1 second) (5 seconds) (15 seconds) (30 seconds)

CORS for Airborne Mapping: Experimental Procedure

- Computed reference trajectory for the aircraft using ground control, aerial triangulation, and temporary GPS base station(s) located near to the flight path.
- The resulting trajectory is considered to have an absolute accuracy of 10 cm.
- For each of 14 CORS, computed a test trajectory from its GPS data.



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CORS for Airborne Mapping: Experimental procedure (continued)

- Considered 14 CORS located from 40 km to 417 km from the centroid of the flight path.
- CORS data were interpolated either from a 30-sec rate to a 1-sec rate or from a 5-sec rate to a 1-sec rate.
- Computed the RMS positional difference between the reference trajectory and each test trajectory over the duration of the flight (~4 hours).

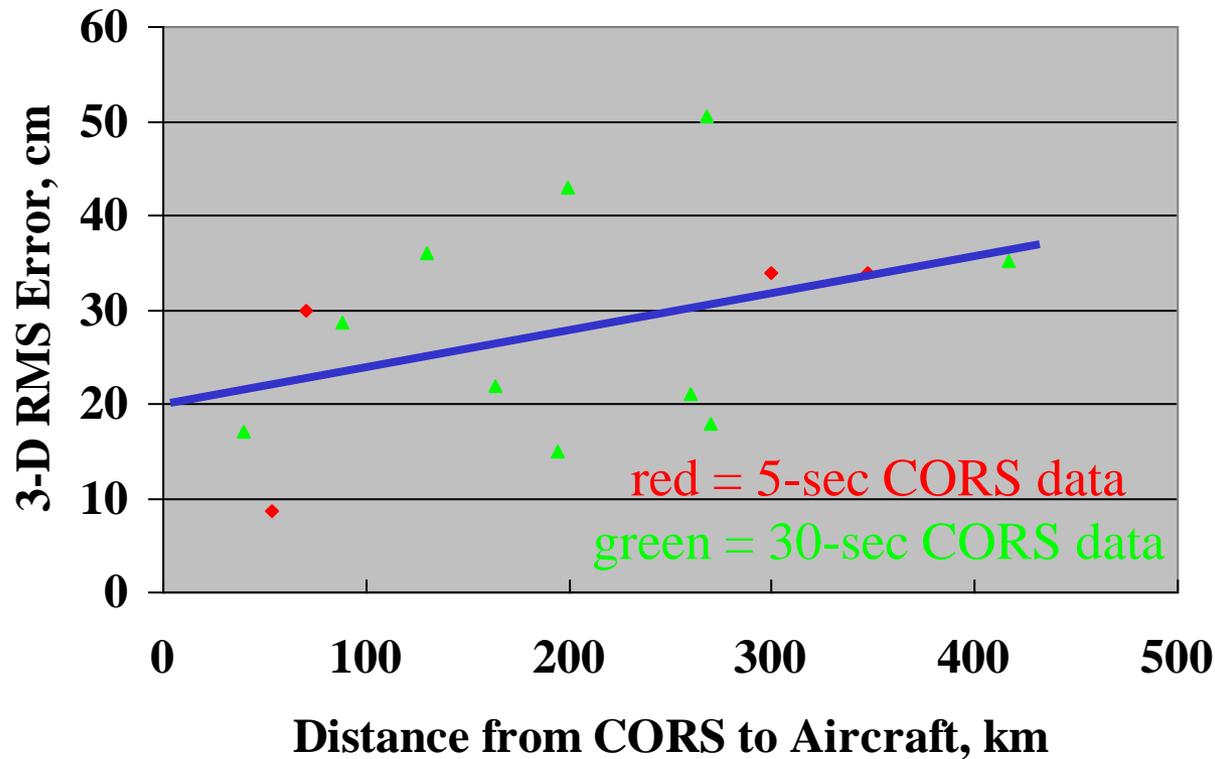


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Aircraft Positioning with CORS



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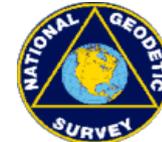
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CORS for Airborne Mapping: Experimental Results

- The RMS values of the 3-D positional difference between the reference trajectory and each of the test trajectories varies from 8.7 cm (site = S300) to 50.5 cm (site = MINS).
- The mean RMS of the 3-D positional differences (for the 14 CORS) is 28.0 cm.
- The RMS 3-D positional differences exhibit a slight dependency on the distance between the CORS and the aircraft, but this dependency is not statistically significant at 0.042 ± 0.026 cm/km.



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CORS for Airborne Mapping: Experimental Results (continued)

- No measurable difference is seen between the accuracy of the test trajectories obtained by interpolating 5-sec CORS data and the accuracy of the test trajectories obtained by interpolating 30-sec CORS data.
- Other experiments indicate that using the GPS data from several CORS, in combination, will produce more reliable aircraft positions.

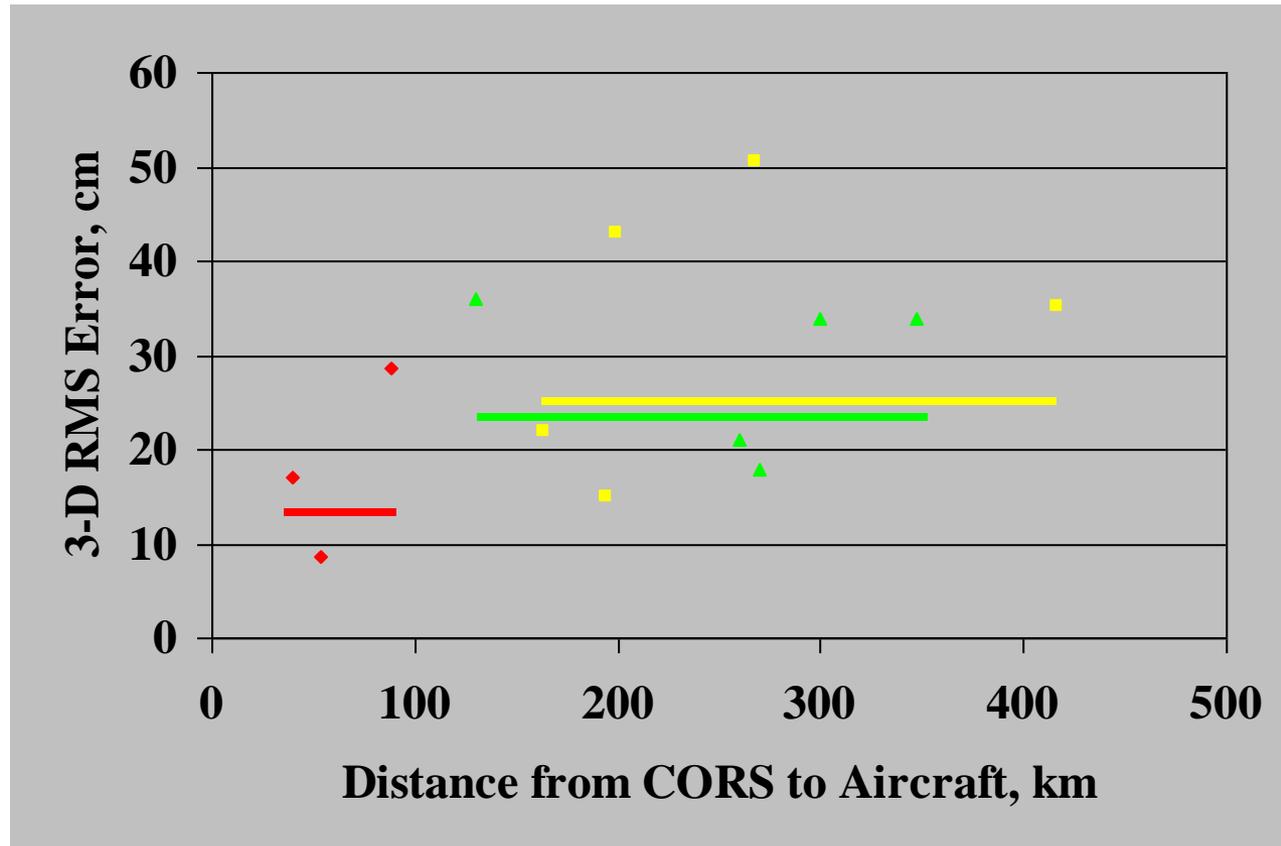


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CORS for Airborne Mapping: Aircraft position from multiple CORS



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CORS for Airborne Mapping: Conclusions

- Using CORS data can save on the cost of establishing temporary GPS base stations for those airborne mapping missions that allow for more than a 30 cm error in the 3-D position of the aircraft.
- CORS data may be used to supplement data from a temporary GPS base station, in case multipath, local obstructions, equipment failures, and/or human errors cause some of the base station's data to be lost.
- Use data from several GPS base stations (including CORS) to position aircraft more reliably.



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Test Design: dual-frequency carrier phase

- Dual Frequency Geodetic Receivers
- Post-Processed with a Precise Orbits
- Pairs of CORS sites forming 11 Baselines
- Baseline lengths ranging from 26 to 300 km
- Various Observation Session Durations
(1, 2, 4, 6, 8, 12, and 24 hours)

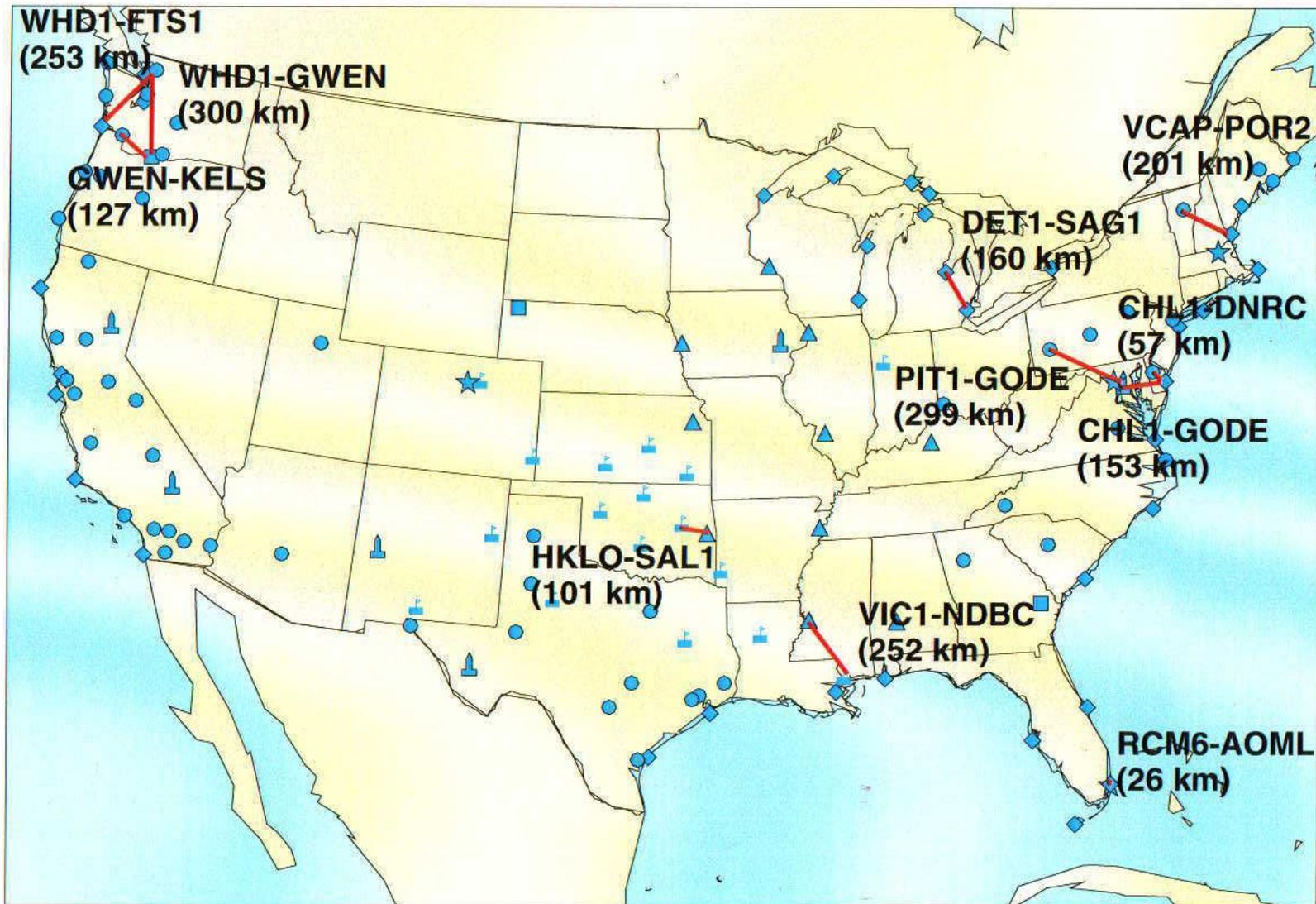


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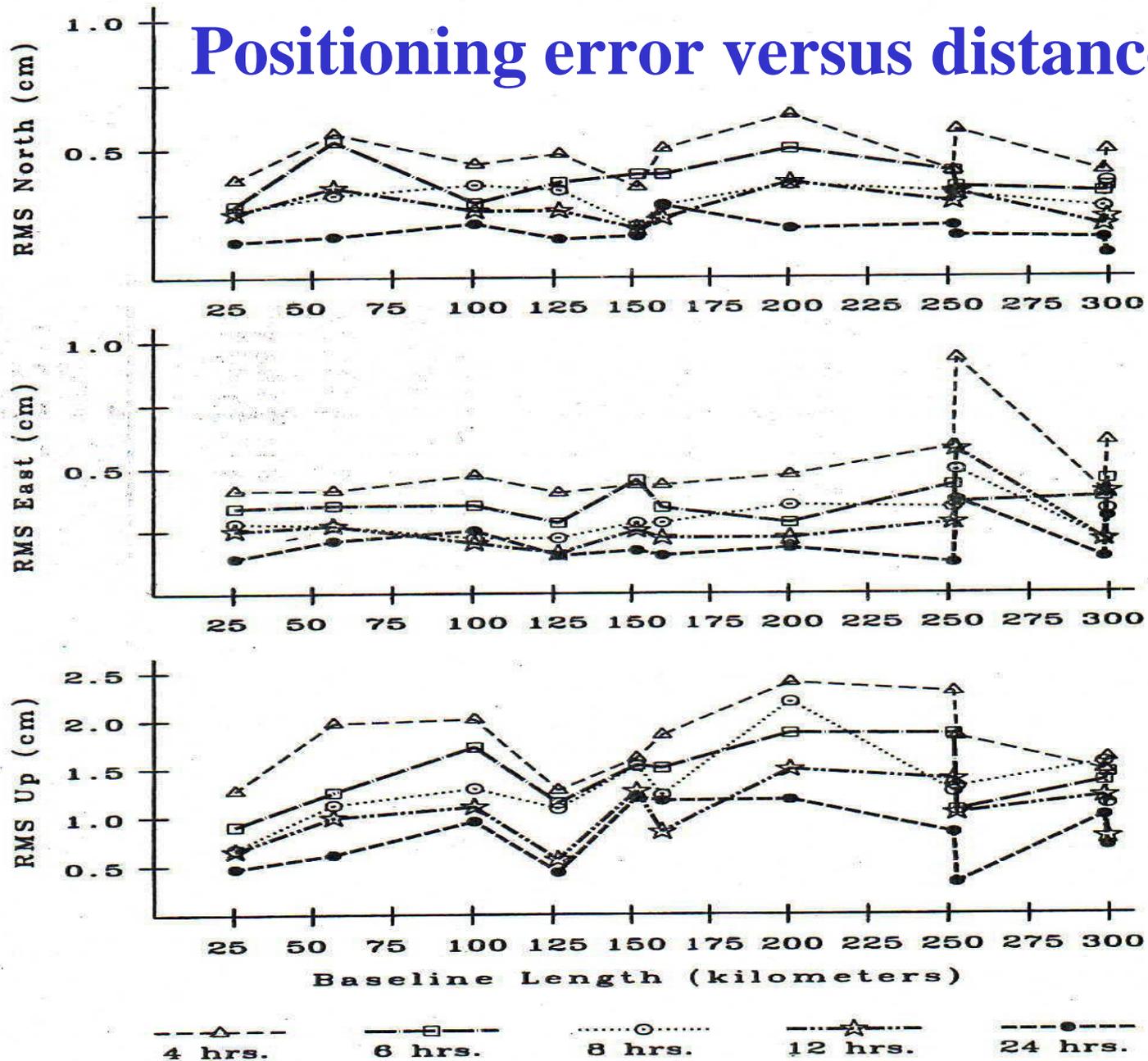


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BASELINES USED IN ACCURACY TESTS

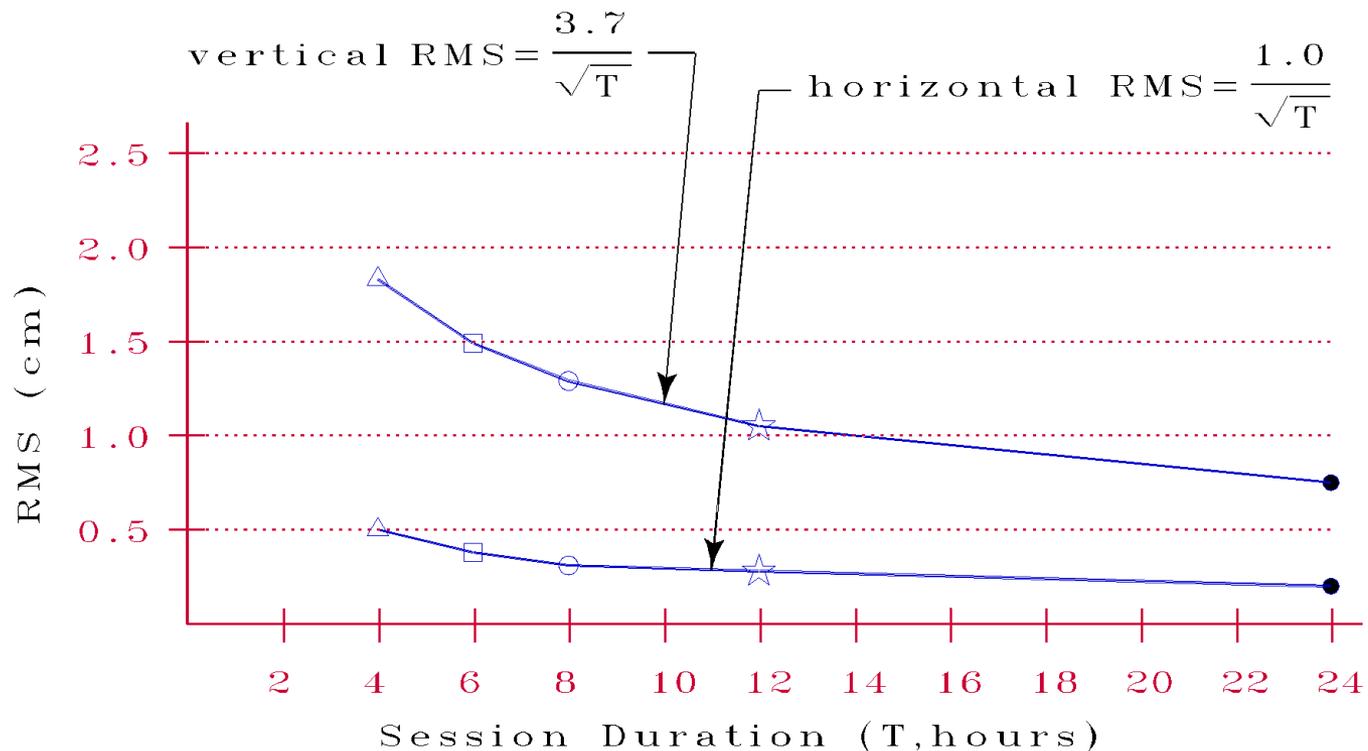


Positioning error versus distance



Positioning Error vs. Duration of the Observing Session

Dual-frequency GPS carrier-phase observations



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Vertical Precision Using Dual-Frequency GPS Carrier Phase Observations

